Percutaneous treatment of a large superior mesenteric artery pseudoaneurysm and arteriovenous fistula: A case report

Khung Keong Yeo, MBBS,[a] David L. Dawson, MD,[a] Jeffrey L. Brooks, MD,[b] and **John R. Laird, MD,[a]**
Sacramento and Napa, Calif

The combination of superior mesenteric artery (SMA) pseudoaneurysm and arteriovenous (AV) fistula is a rare complication following penetrating abdominal trauma. We report a case of a post-traumatic SMA pseudoaneurysm and large fistula between the SMA and superior mesenteric vein (SMV), which was successfully treated with an endovascular stent graft. (J Vasc Surg 2008;48:730-34.)

CASE REPORT

A 39-year-old female had sustained an abdominal gunshot wound 20 years earlier. She recovered from her injuries and remained asymptomatic until the past year when she developed progressive abdominal pain. Physical examination revealed tenderness to palpation, fullness in the upper abdomen, and a loud continuous bruit. Computed tomography (CT) scan of the abdomen demonstrated a pseudoaneurysm arising from the SMA and a large AV fistula between the SMA and SMV, with marked dilatation of the SMV and portal veins (Fig 1). On the basis of the localized nature of the pain on clinical examination, the patient's symptoms were thought to be due to mass effect of the pseudoaneurysm, with possibly some component from hepatic venous congestion. There was no evidence of high output cardiac failure or gastrointestinal bleeding or other clinical manifestations of portal venous hypertension.

In light of the history of prior abdominal injury and operation, and the findings that suggested mesenteric venous hypertension, she was judged to be at risk of bleeding complications with direct surgical repair. She was referred for angiography and possible transcatheter intervention. Abdominal aortography was performed in the anterior-posterior and lateral projections with the use of a 5F pigtail catheter (Fig 2). A 5F Simmons-1 catheter (Cordis, Miami Lakes, Fla) was then used to engage the SMA, and selective angiography was performed. High flow into the AV fistula limited visualization of the SMA branch vessels. An angled glide catheter (Terumo, Ann Arbor, Mich) was advanced over a guidewire more distally in the SMA; however, visualization remained poor. A 7F Ansel sheath (Cook Medical, Bloomington, Ind) was then advanced into the SMA over the guidewire. Intravenous heparin was administered to maintain an activated clotting time >250 seconds. A 6-mm diameter by 2-cm long Powerflex Plus angioplasty balloon (Cordis, Miami Lakes, Fla) was advanced into the SMA, and balloon occlusion angiography of the SMA was then performed. The SMA pseudoaneurysm and fistula, as well as the SMA branch vessels, were then well visualized (Fig 2), which allowed a better determination as to whether a covered stent could be safely deployed without occluding important branch vessels. A 7-mm diameter by 16-mm long iCAST covered-stent (Atrium Medical, Hudson, NH) was then deployed over the origin of the AV fistula and pseudoaneurysm. Subsequent angiography demonstrated incomplete sealing of the pseudoaneurysm and AV fistula. A second 7-mm diameter by 22-mm long iCAST stent was deployed more proximally, overlapping the first device. Subsequent angiography demonstrated complete exclusion of the pseudoaneurysm and AV fistula. Post-dilatation of the proximal stent graft with an 8-mm diameter by 2-cm long Powerflex Plus balloon (Cordis, Miami Lakes, Fla) was performed. Subsequent angiography demonstrated an excellent angiographic result with complete exclusion of the pseudoaneurysm and AV fistula, and preservation of important SMA branches (Fig 3).

The procedure was well tolerated and there were no subsequent complications. The patient's symptoms of abdominal discomfort resolved after the procedure, as did the abdominal bruit. She was maintained on aspirin and clopidogrel for 6 months to prevent subacute stent thrombosis. Because of the grossly distended SMV and a concern for the potential of SMV thrombosis after closure of the AV fistula, she was also anticoagulated with warfarin for 6 months. There were no bleeding complications. After 6 months, she was continued on aspirin only. She remained asymptomatic at 6-month follow-up. A repeat CT angiogram at that time showed no SMA pseudoaneurysm or AV fistula and resolution of the previously noted portal venous distension (Fig 4).

DISCUSSION

Abdominal visceral aneurysms and pseudoaneurysm are associated with a significant risk of rupture and death.[1,2] In a case series from the Cleveland Clinic of 90 patients, 8 presented with ruptures.[2] Of the 48 patients treated percutaneously, the 30-day mortality was 8.3%. The natural history of SMA aneurysms and pseudoaneurysm is not well described in the literature. The largest case series is reported from the Mayo Clinic in which 21 patients with SMA aneurysms were identified.[3] In this series, eight

From the Vascular Center, University of California, Davis Medical Center,[a] Sacramento, and Trancas Surgical Associates,[b] Napa.

Competition of interest: Dr Laird serves on the advisory boards of Cordis, Boston Scientific, Medtronic, Edwards Lifesciences, and eV3.

Reprint requests: John R. Laird, MD, 4860 Y Street, Ste 3400, Sacramento, CA 95817 (e-mail: john.laird@ucdmc.ucdavis.edu).

0741-5214/$34.00

doi:10.1016/j.jvs.2008.03.056

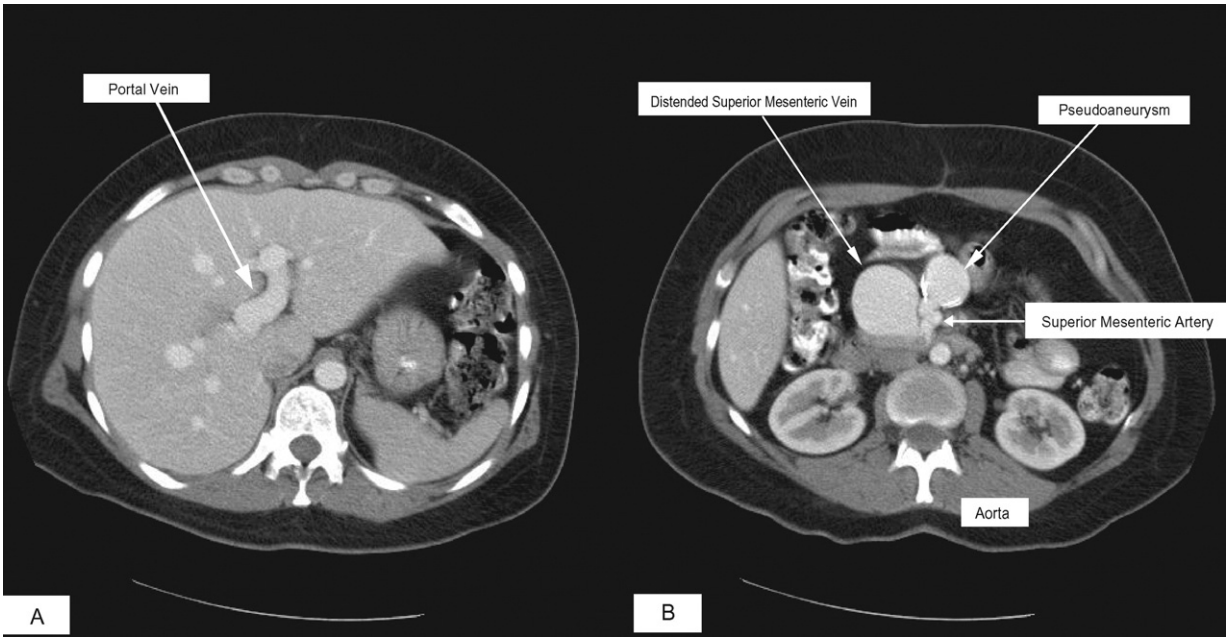

Fig 1. Pretreatment computed tomography scan of abdomen. **A,** Shows early contrast in a dilated portal venous system (*arrow*). **B,** Shows the distended superior mesenteric vein, superior mesenteric artery, and pseudoaneurysm (*arrows*).

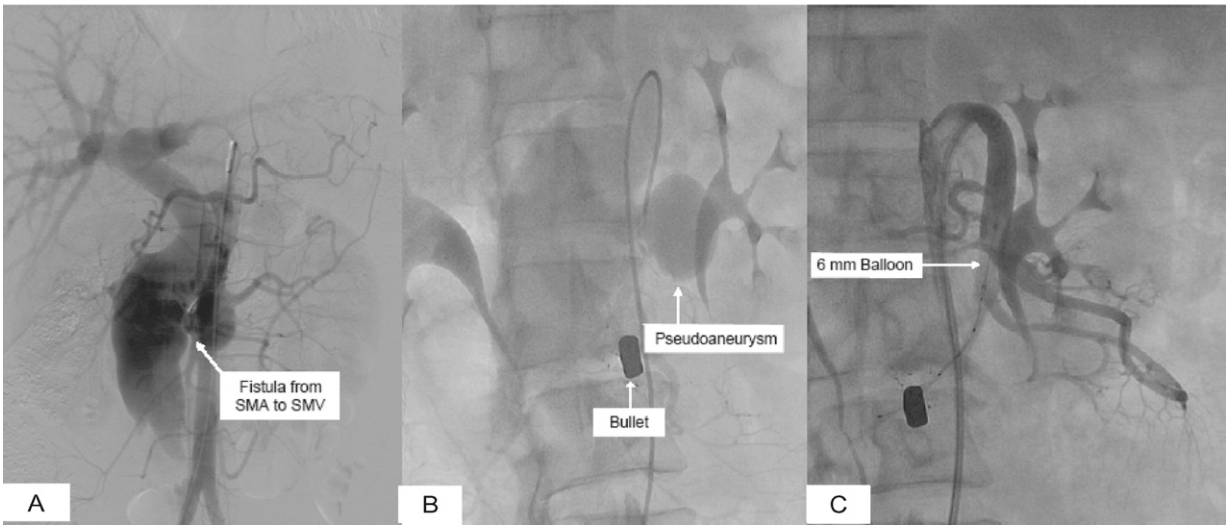

Fig 2. Pretreatment angiography. **A,** Shows the superior mesenteric artery (SMA) to superior mesenteric vein (SMV) arteriovenous fistula. **B,** Shows the SMA pseudoaneurysm. **C,** Balloon occlusion angiography of the SMA with improved visualization of the branches of the SMA.

patients presented with rupture and, of these, the operative mortality for repair was 37.5%. Patients who underwent elective repair had no associated mortality. The authors therefore concluded that SMA aneurysms pose an important risk of rupture and should be treated if the operative risk is low.

Endovascular treatment of SMA aneurysm or pseudoaneurysm. Most reports have focused on the use of coils to embolize SMA aneurysms and pseudoaneurysms.[4-7] Other embolic agents have been used, including cyanoacrylate and thrombin.[2,7,8] A few case reports and case series also describe the use of stents and stent grafts to exclude these lesions.[7,9-12] In general, these reports (which comprise small numbers of patients) show durable results with duration of follow-up from 3 months to 5 years.[9-12] One case report described an endoleak at the distal edge of a covered stent at 3 months,[13] which was subsequently treated by thrombin injection.

Fig 3. Posttreatment angiography. **A,** Shows the overlapping iCAST stents in the superior mesenteric artery (SMA). **B and C,** Show different views of the SMA with complete exclusion of the fistula and pseudoaneurysm.

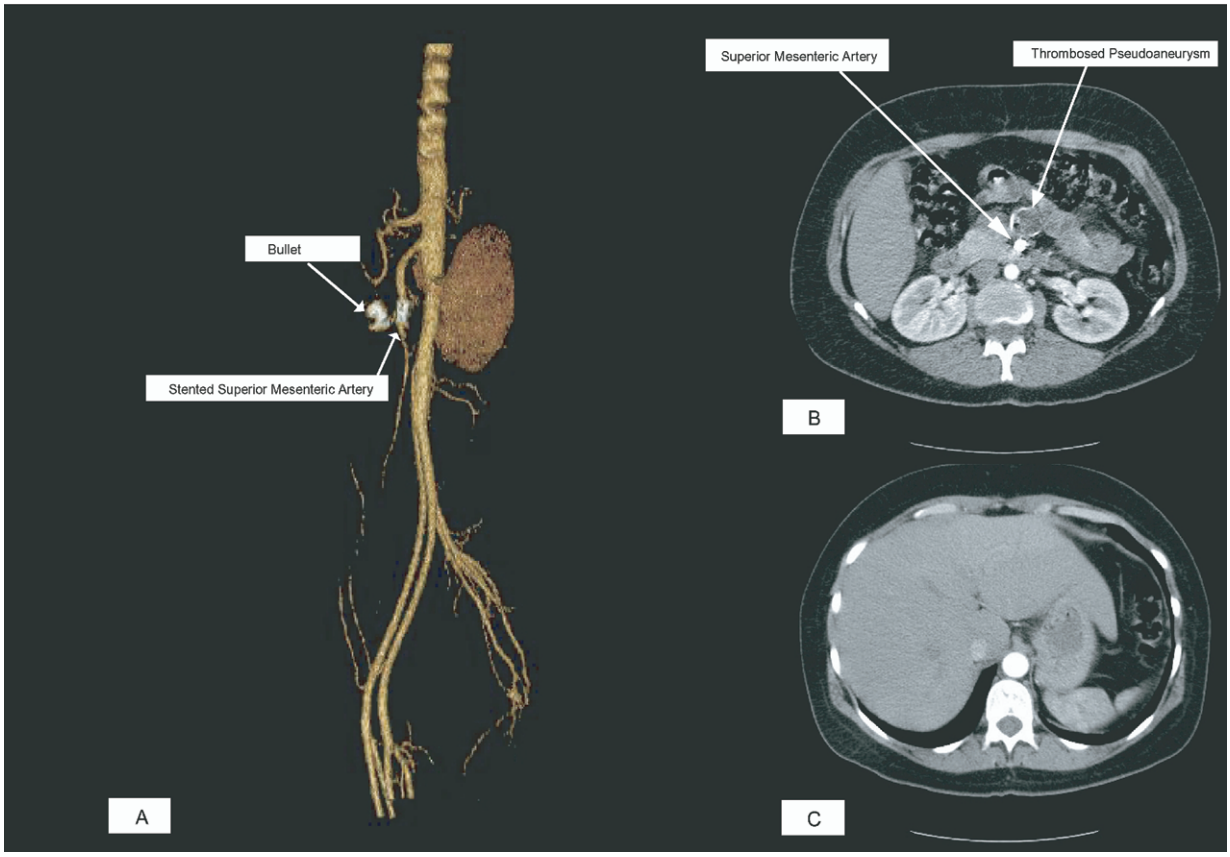

Fig 4. Posttreatment computed tomography scan of abdomen. **A,** Three-dimensional reconstruction of the aorta and superior mesenteric artery (SMA). **B,** Shows the SMA, thrombosed pseudoaneurysm, and absence of early contrast in the superior mesenteric vein.

Visceral AV fistulae. Non-congenital visceral AV fistulae are uncommon and exist in the published literature primarily as case reports and case series. Occurrence of SMA-SMV fistulae are exceedingly rare and have been primarily associated with traumatic injuries, including gunshot wounds or abdominal surgery.[14-16] Delayed presentation of SMA-SMV AV fistulae can occur up to 10 years after an initial injury.[14,17] Clinically, these fistulae can cause

symptoms of mesenteric ischemia such as diarrhea or abdominal pain and symptoms of portal hypertension including variceal bleeding.[14,16,18-21] If the systemic-portal fistula is recognized early, treatment may result in reversal of the portal hypertension. In addition, aneurysmal dilatation of the SMV as a result of the fistula may predispose to thrombotic portal venous obstruction.[21]

The treatment of visceral AV fistulae, in particular SMA-SMV fistulae, may be surgical[14,15] or endovascular. Endovascular repair has involved the use of embolization coils and covered stents.[18,19,22] To the best of our knowledge, our case is the second report describing the use of a covered stent to treat an SMA-SMV AV fistula.[22] In the case of coil embolization, important considerations include the risk of distal embolization into the portal vein, which may lead to portal vein thrombosis.[18,20] The coils may also embolize into the distal SMA or back into the aorta, potentially resulting in bowel infarction or lower extremity ischemia.

There are limited data on the combination of SMA pseudoaneurysm and AV fistula. In a case similar to the one presented, Rosenthal et al[16] described a combination of aorto-superior mesenteric bypass and postoperative percutaneous transcatheter embolization to treat a patient with a traumatic SMA-SMV fistula and an SMA pseudoaneurysm.

Technical aspects: stent graft. High flow in the AV fistula as well as close proximity of the artery and vein made successful coil embolization unlikely. This case report illustrates the treatment of a visceral AV fistula and pseudoaneurysm using stent grafts, the objective of which is to close the AV fistula and seal the pseudoaneurysm without occluding flow into the side branches. Balloon-expandable covered stents (eg, iCAST) provide significant advantages over a self-expanding stent graft by allowing more precise deployment, which is of particular importance in avoiding the mesenteric branch vessels. Furthermore the iCAST covered stent comes in diameters of 5 to 10 mm, can be delivered through a 6F or 7F sheath, and has a wide expansion range, allowing for further expansion of the stent if the initial deployment was undersized. On the other hand, self-expanding covered stents have a relatively limited range of expandability. In this case report, the first covered stent did not adequately seal the AV fistula and pseudoaneurysm. One possible explanation is that the iCAST covered stent shortens slightly when expanded, possibly resulting in an uncovered communication from the SMA and pseudoaneurysm proximally. A second stent graft was placed more proximally, resulting in complete sealing. Of note, the placement of any balloon-expandable stent across sharp bends (which may be seen in the proximal SMA) may potentially result in abnormal vessel straightening, vessel injury, or stent deformation. In this particular case, the area of interest in the SMA was distal to the sharp bend and was in a straight segment, allowing for safe deployment of the stent.

There are important caveats for the use of covered stents. Good expansion of the stent graft and good apposition of the stent to the vessel wall are critical to minimize the risk of subacute or late stent thrombosis, which can potentially lead to acute organ ischemia and infarction. Therefore, dual antiplatelet therapy with aspirin and a thienopyridine are empirically recommended in the postimplantation period with subsequent life-long treatment with aspirin. The role and optimal duration of dual antiplatelet therapy remain unclear. Finally, long-term results of stent grafts in this setting remain unknown, with stent thrombosis leading to acute mesenteric ischemia being an important concern.

REFERENCES

1. Arneson MA, Smith RS. Ruptured hepatic artery aneurysm: case report and review of literature. Ann Vasc Surg 2005;19:540-5.
2. Tulsyan N, Kashyap VS, Greenberg RK, Sarac TP, Clair DG, Pierce G, et al. The endovascular management of visceral artery aneurysms and pseudoaneurysms. J Vasc Surg 2007;45:276-83; discussion 283.
3. Stone WM, Abbas M, Cherry KJ, Fowl RJ, Gloviczki P. Superior mesenteric artery aneurysms: is presence an indication for intervention? J Vasc Surg 2002;36:234-7; discussion 237.
4. Carroccio A, Jacobs TS, Faries P, Ellozy SH, Teodorescu VJ, Ting W, et al. Endovascular treatment of visceral artery aneurysms. Vasc Endovascular Surg 2007;41:373-82.
5. Chiesa R, Astore D, Guzzo G, Frigerio S, Tshomba Y, Castellano R, et al. Visceral artery aneurysms. Ann Vasc Surg 2005;19:42-8.
6. Gabelmann A, Gorich J, Merkle EM. Endovascular treatment of visceral artery aneurysms. J Endovasc Ther 2002;9:38-47.
7. Lagana D, Carrafiello G, Mangini M, Dionigi G, Caronno R, Castelli P, et al. Multimodal approach to endovascular treatment of visceral artery aneurysms and pseudoaneurysms. Eur J Radiol 2006;59:104-11.
8. Miller MT, Comerota AJ, Disalle R, Kaufman A, Pigott JP. Endoluminal embolization and revascularization for complicated mesenteric pseudoaneurysms: a report of two cases and a literature review. J Vasc Surg 2007;45:381-6.
9. Cowan S, Kahn MB, Bonn J, Becker GJ, Dimuzio P, Leichter R, et al. Superior mesenteric artery pseudoaneurysm successfully treated with polytetrafluoroethylene covered stent. J Vasc Surg 2002;35:805-7.
10. Gandini R, Pipitone V, Konda D, Pendenza G, Spinelli A, Stefanini M, et al. Endovascular treatment of a giant superior mesenteric artery pseudoaneurysm using a nitinol stent-graft. Cardiovasc Intervent Radiol 2005;28:102-6.
11. Larson RA, Solomon J, Carpenter JP. Stent graft repair of visceral artery aneurysms. J Vasc Surg 2002;36:1260-3.
12. Rossi M, Rebonato A, Greco L, Citone M, David V. Endovascular exclusion of visceral artery aneurysms with stent-grafts: technique and long-term follow-up. Cardiovasc Intervent Radiol 2008;31:36-42.
13. Szopinski P, Ciostek P, Pleban E, Iwanowski J, Serafin-Krol M, Marianowska A, et al. Percutaneous thrombin injection to complete SMA pseudoaneurysm exclusion after failing of endograft placement. Cardiovasc Intervent Radiol 2005;28:509-14.
14. Chen YC, Tan GA, Lin BM, Khor C. Superior mesenteric arteriovenous fistula presenting 10 years after extensive small bowel resection. Aust N Z J Surg 2000;70:822-3.
15. Chiriano J, Abou-Zamzam AM Jr, Teruya TH, Ballard JL. Delayed development of a traumatic superior mesenteric arteriovenous fistula following multiple gunshot wounds to the abdomen. Ann Vasc Surg 2005;19:470-3.
16. Rosenthal D, Ellison RG Jr, Luke JP, Clark MD, Lamis PA. Traumatic superior mesenteric arteriovenous fistula: report of a case and review of the literature. J Vasc Surg 1987;5:486-91.
17. Francois F, Thevenet A. Superior mesenteric arteriovenous fistula after ileal resection. Ann Vasc Surg 1992;6:370-2.
18. Desai SB, Modhe JM, Aulakh BG, Ravi R, Sukthankar RU, Pardiwalla BB. Percutaneous transcatheter steel-coil embolization of a large prox-

imal post-traumatic superior mesenteric arteriovenous fistula. J Trauma 1987;27:1091-4.
19. Diehl JT, Beven EG. Arteriovenous fistulas of the mesenteric vessels. Report of a case and review of the literature. J Cardiovasc Surg (Torino) 1982;23:334-7.
20. Shih FC, Wang SJ, Dang KJ, Su CJ, Chan CC, Tan KH, et al. Successful management of traumatic mesenteric arteriovenous fistula after failure of steel coil embolization: case report. J Trauma 1994;37:682-6.
21. Wang BW, Wu DH, Lin CK, Huang JS, Mok KT. Superior mesenteric arteriovenous fistula associated with portal obstruction. Zhonghua Yi Xue Za Zhi (Taipei) 2001;64:586-91.
22. Wu CG, Li YD, Li MH. Post-traumatic superior mesenteric arteriovenous fistula: endovascular treatment with a covered stent. J Vasc Surg 2008;47:654-6.

Submitted Feb 8, 2008; accepted Mar 29, 2008.